forest management note

Note No. 36 Northern Forestry Centre Edmonton, Alberta

FERTILIZATION IMPROVES STAND PRODUCTIVITY OF PREHARVEST LODGEPOLE PINE

For improving yield of lodgepole pine stands, fertilization is second only to density control by spacing and thinning. Substantial responses to heavy N, P, and S fertilization have been reported in Oregon (Cochran 1975, 1979) in a thinned, semimature stand; N fertilizer alone improved the yield of a thinned stand in western Alberta (Bella 1978).

This Note summarizes the results of fertilizing 70-year-old stands on two major soil types (Coalspur and Mercoal) near Hinton, Alberta. Fertilization in 1971 increased the net stand total volume production by as much as 50% over the unfertilized stands after 10 years of growth. More details were presented by Yang (1985).

The two study areas, located approximately 50 and 100 km south of Hinton, were each divided into three blocks. A block contained 24 circular plots, 0.07 ha each, on a square grid at 30-m intervals. Diameter at breast height outside bark (dbhob) of all living trees on each plot was tallied in 1971 before fertilization and was remeasured in 1981 after 10 growing seasons. Nutrient sources were urea, triple superphosphate P, and elemental sulfur; dosages are summarized in Table 1. Foliar analysis prior to fertilization indicated a possible deficiency in N for trees on both soils.

Table 1. Nutrient dosages used in the study

Treatment	Nutrient dosage (kg/ha) N	P	S
0	0	0	0
1	76	38	23
2	188	94	56
3	300	150	90
4	377	188	113

TREE DIAMETER INCREMENT

Nitrogen applications of 300 kg/ha consistently improved diameter growth on Coalspur soils, but diameter increment response to fertilization was less consistent on Mercoal soils, which had higher initial N levels and stand density (Fig. 1). In addition to the significant N effect, a significant N × S interaction suggests that S is limiting to lodgepole pine growth on Mercoal soils.

NET STAND INCREMENT

Tree mortality was appreciably higher for the Mercoal stand (0–16.7% average mortality) than for the Coalspur (0–6.7%). Despite mortality, four treatments on the Coalspur and two on the Mercoal soils significantly improved total stand and merchantable volume production. Fertilization treatments improved stand productivity

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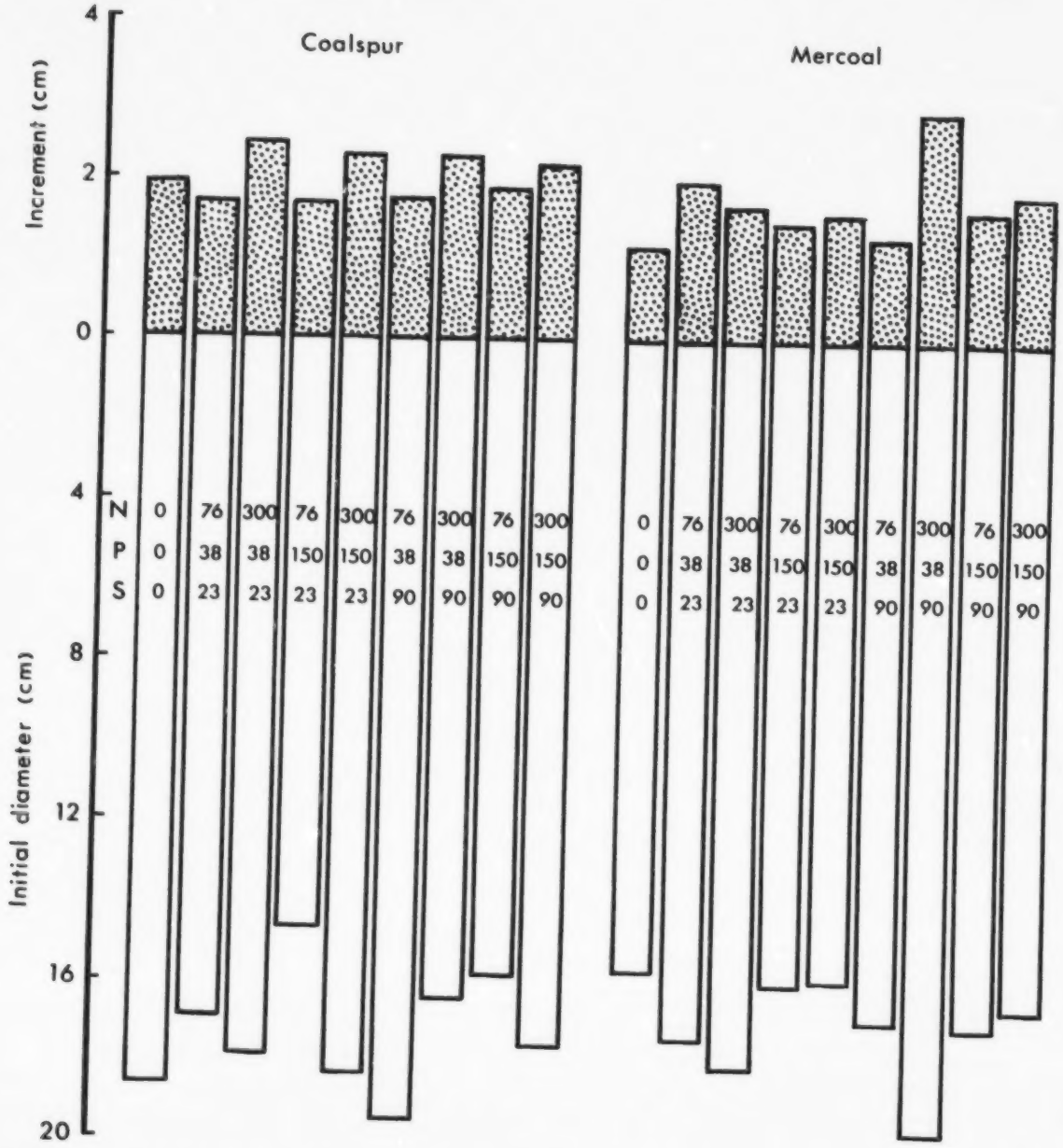

Figure 1. Initial diameter and 10-year increments in response to N, P, and S fertilization. Numbers in bars are fertilizer application rates in kg/ha.

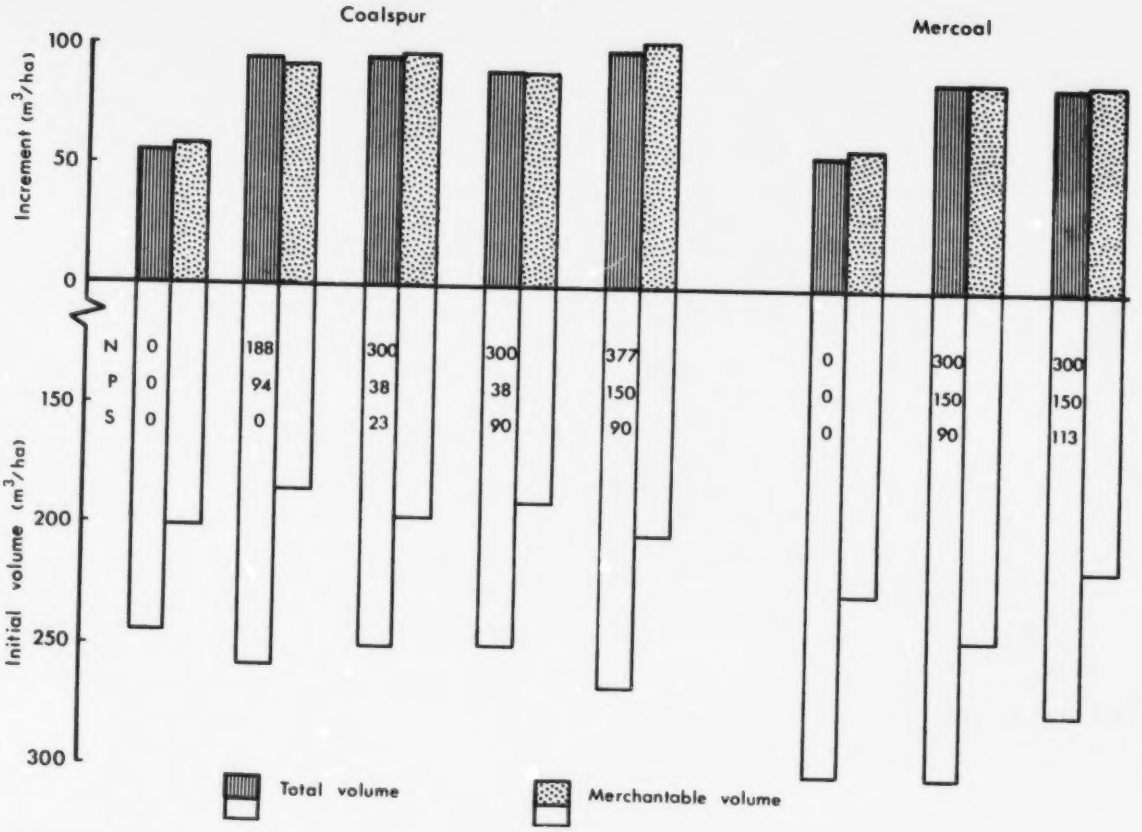

Figure 2. Initial volumes and net total and merchantable volume increments of controls and significant treatments. Numbers in bars are fertilizer application rates in kg/ha.

by as much as 31–34 m^3 in total and by 28–33 m^3 in merchantable volume per hectare over the 10-year period for the Coalspur and Mercoal stands (Fig. 2). This is a 50% improvement in wood production in that period. Nitrogen was the nutrient in greatest demand for lodgepole pine growth, and at least 188 kg/ha of N is needed for a significant growth response on Coalspur soils (Fig. 2). These growth responses confirm what has been indicated by pretreatment soil and foliar analyses, especially on Coalspur soils, which had greater nitrogen deficits.

POTENTIAL IMPACT OF FERTILIZATION

To illustrate the potential impact of fertilization in an operational setting, the McLeod working circle of St. Regis (Alberta) Ltd. at Hinton was chosen as an example. This working circle contains 163 300 ha of productive forest land just south of the mill; 48% is in the lodgepole pine cover type. Coalspur and Mercoal soils make up about 29% of the productive land area, of which about 1 680 ha is made up of 70-year-old lodgepole pine. Assuming that average stand conditions in this area would be similar to those found in the study area, an application of 300, 150, and 90 kg/ha of N, P, and S over this 1 680 ha area could yield 36 000 m^3 of additional merchantable wood at a cost of \$10.80/m^3.

ECONOMIC CONSIDERATIONS

The biological response of stands to fertilization should be evaluated in economic terms before operational treatments are implemented. These types of economic analyses are currently in progress at the Northern Forestry Centre. The following points should be considered when conducting such an analysis.

The total cost of fertilization includes the cost of fertilizers, their transportation and application, and interest. Costs of fertilizers, transportation, and application average from $85/ha for applying S at 23 kg/ha, to $370/ha for applying 377, 94, and 56 kg/ha of N, P, and S in combination.

In selecting potential stands for fertilization, the three main factors to be considered are stand age, site quality, and stem size.

Stand age. Because interest on investment is compounded, fertilization of mature stands shortly before harvest is generally the best option. This option also lowers the risk of subsequent losses from insects, disease, and fire.

Site quality. The profitability of a fertilization operation depends largely on the site quality of the stand. Growth response to fertilization is generally greater on lower quality sites than on good sites (Morrison et al. 1976). Site quality of Coalspur soils was somewhat inferior to that of Mercoal soils (Dumanski et al. 1972). Fertilization response was consequently better on Coalspur than on Mercoal stands. Better financial returns can be assured by careful screening of candidate stands for fertilization.

Stem size. Larger stems have a higher unit price and lower logging costs than smaller stems. For the same volume response, fertilizing larger trees will be more profitable than fertilizing smaller trees on similar sites.

PERSPECTIVE

Boreal forests in the prairie region are similar to forests in Scandinavia, where forest fertilization has become an operational management technique for increasing stand productivity on a limited land base. In Canada, where shortages of economically accessible timber are only local, increasing wood supply through fertilization has not yet been widely practiced. In view of increasing labor, logging, and transportation costs, fertilizers may be applied in the future on a substantial scale for the express purpose of increasing timber production in the vicinity of wood processing facilities. Results from this study demonstrate that lodgepole pine responds favorably to preharvest fertilization. Many technical, economic, and environmental questions have to be answered, however, before operational fertilization becomes feasible. Continued research and semioperational trials will provide additional needed information.

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August 1986

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